Muscle oxygenation monitoring using near infrared spectroscopy during sport activities

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Abstract

In sports medicine one of the fundamental tasks is to assess the physical performance of athletes. Today extensive tests like ergospirometry, measurement of lactate levels etc. are used in sports medicine. A direct measurement of the oxygen balance in the muscle non-invasively, continuously and mobile is desirable. Even though Near infrared spectroscopy (NIRS) is used to assess muscle oxygenation, accurately measuring muscle oxygenation is still a challenging task, in particular for more natural scenarios such as those encountered during sport activities.

There has been much development in the NIRS technology to make the measurements more effective. Among these sensors the OXY-DR1 system, manufactured by OXY4 GmbH/Germany, represents a new tool for the performance diagnostics in sport science. It employs continuous wave NIRS by emitting light from 7 different LEDs with wave-lengths between 500 (visible) and 910 nm (near-infrared) and detection of the reemitted light at different distances from the light sources.

The purpose of this study is to develop signal extraction algorithms based on time resolved intensity data of the emitted light of the OXY-DR2 system. We used the Modified Beer-Lambert (MBL) method to measure the concentration change in oxyhemoglobin (O2Hb) and deoxyhemoglobin (HHb). Also we used the Spatially Resolved Spectroscopy (SRS) method to measure the Tissue Oxygenation Index (TOI).

Here we present the results of a first experimental study to evaluate the change of the calculated parameters during different sport activities. More specifically, we have recorded the intensity of the reflected light from different tissue locations during different scenarios (normal perfusion, venous and arterial occlusion, running, jumping, calf extension and knee bending). The calculated parameters are consistent with the expected behavior. Future investigation should limit the study to specific regions of muscle as well as to specific load scenarios and types of exercises engaged. Another future aspect will be the development of artifact recognition methods to improve the sensor performance during sport activities like running, cycling etc.